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Growth and Movement of Shovelnose Sturgeon in the Chippewa River, Wisconsin, 1972-1979

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Abstract

A total of 1,222 shovelnose sturgeon, *Scaphirynchus platorynchus*, were captured by electrofishing, tagged, and released in a 23-mile study reach of the Chippewa River, Wisconsin, during the period 1972-1977. Of that number, 261 fish were recaptured by electrofishing, of which 210 were recaptured once and 51 were recaptured 2 to 4 times through 1979. Another 18 fish were recaptured by anglers through 1983. The sampled sturgeon population ranged in fork-length intervals from 19.0-19.4 to 31.5-31.9 inches, and the average weight was 2.2 lb. Growth rate, determined empirically from comparative measurements of fish at tagging and recapture, averaged only 0.03 inch/year. Movement was determined by comparing release and recapture locations. Fifty percent of the recaptures moved upstream an average of 1.2 miles, 44% moved downstream an average of 1.7 miles, and 6% displayed movement of less than 0.1 mile. Maximum movement of fish recaptured by electrofishing was 9.8 miles upstream and 9.7 miles downstream. Returns from anglers were from as far as 24 miles upstream and 21 miles downstream, indicating that shovelnose sturgeon are capable of longer movements. Movement observed in this study was typically limited and showed no consistent upstream or downstream pattern, but seasonal and spawning migrations could not be characterized with this sampling design.

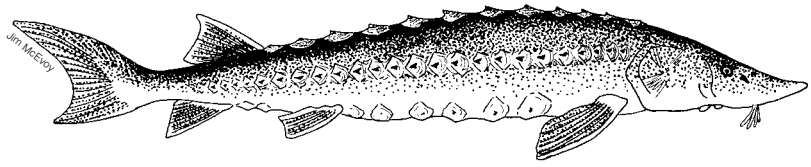

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Figure 1. *Presence of shovelnose sturgeon in Wisconsin.*

Introduction

The shovelnose sturgeon, *Scaphirynchus platorynchus*, is widely distributed in large rivers of the Mississippi River basin, but information on its life history is not widely available. Much of what is known about shovelnose sturgeon biology has appeared in theses (Held 1966, Zweiacker 1967, Modde 1973, Moos 1978, Schuckman 1982, Hurley 1983, Curtis 1990) or in governmental agency publications with limited distribution (Helms 1974*a*, Schmulbach 1974, Christenson 1975, Elser et al. 1977, Berg 1981, Carlson and Pflieger 1981, Hurley and Nickum 1984). Several of the above reports or portions thereof were the bases for papers later published in scientific journals (Held 1969, Helms 1974*b*, Modde and Schmulbach 1977, Carlson et al. 1985, Hurley et al. 1987).

The distribution of shovelnose sturgeon in Wisconsin is well documented (Figure 1). Shovelnose sturgeon are known to be present only in the Mississippi River and its major tributaries: the Wisconsin River upstream to the Prairie du Sac dam, the Chippewa River upstream to the Dells dam in Eau Claire, the Red Cedar River upstream to the Menomonie dam, and the St. Croix River upstream to the St. Croix Falls dam (Becker 1983). Christenson (1975) suspected it was present in the Black River below the Black River Falls dam, but it was not collected in subsequent surveys (Fago 1983, 1992).

Less is known about the life history and biology of the shovelnose sturgeon in Wisconsin. Christenson (1975) documented length frequency, growth, fecundity, and population sizes of shovelnose sturgeon populations in parts of the Red Cedar and Chippewa rivers. Helms (1974*a*, 1974*b*) provided more detailed information on harvest, age, growth, movement, fecundity, food habits, and population sizes for shovelnose sturgeon in the pools of the Mississippi River that border Iowa.

This study of shovelnose sturgeon was initiated in 1972 on the Chippewa River to better understand the ecology of this species in Wisconsin waters. The overall objective of the study was to collect information on three aspects of the shovelnose sturgeon's life history—reproductive characteristics, movement, and growth. This report focuses on movement and growth based on an analysis of tagged-sturgeon recapture data. Reproductive characteristics will be the subject of a later report.

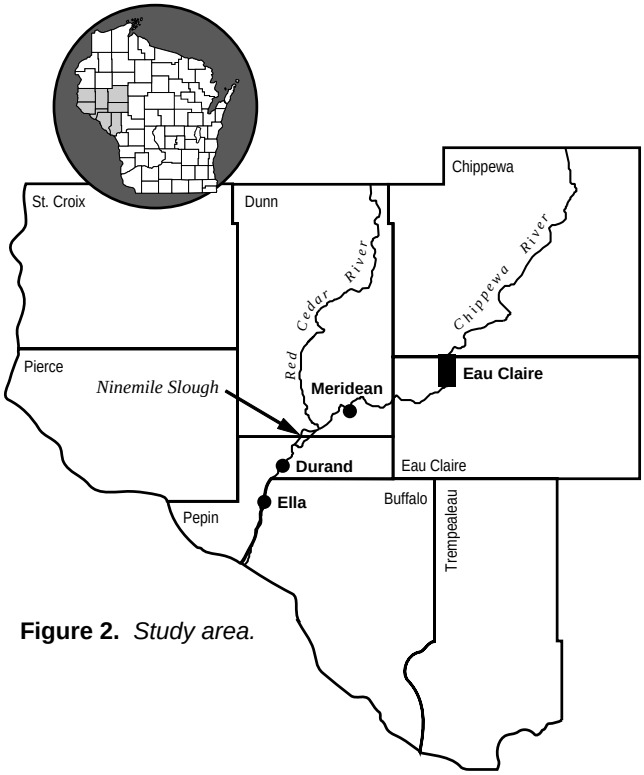

Figure 2. *Study area.*

Study Area

The study area was the Chippewa River from Meridean, Wisconsin, downstream to Ella, Wisconsin, in Dunn, Pepin, and Buffalo counties (Figure 2). The sampled reach covered a distance of 23 miles and lay within the 40-mile free-flowing reach between the Dells dam in Eau Claire and the junction with the Mississippi River. The Chippewa River at Durand has a 9,010 square mile watershed and an average annual discharge of 7,222 cfs (Young and Hindall 1972). Between Eau Claire and the mouth of the Chippewa River the average width ranges from 520 to 800 ft, the gradient is 1.5 ft/mile (Balding 1992), and the substrates are primarily sand and gravel.

Methods

Shovelnose sturgeon were captured by electrofishing with a 230-volt ac boom shocker, moving primarily in a downstream direction. Fork length was measured to the nearest 0.1 inch. Weight was recorded to the nearest 0.5 oz and subsequently converted to pounds. Fork length was the measurement of choice because total length would have included the caudal filament, a unique extension of the longer upper lobe of the heterocercal tail. This filament was usually broken off early in life at varying distances beyond the end of the upper caudal lobe. In addition, the caudal lobe was frequently eroded and malformed.

Fish were tagged with a numbered aluminum strap tag encircling the caudal peduncle at the base of the caudal fin. Capture, release, and recapture sites were recorded on maps (scale: 4 inches = 1 mile) and then transposed to 7 1/2' U.S. Geological Survey topographical maps. Entries were considered to be accurate within 0.1 mile.

Boom-shocker sampling runs to tag and recapture sturgeon were made on 44 dates from 1972 to 1979 (Table 1). Sampling effort varied substantially between reaches of the study area. Effort was concentrated between the mouth of the Red Cedar River and Durand, 16 dates on the full 10.5-mile reach and 18 dates on the 3.5-mile subarea between the mouth of Ninemile Slough and Durand. The river downstream from Durand was sampled on six dates, on only four of which did operations extend to Ella. The reach above the mouth of the Red Cedar River was sampled on four dates, on only one of which did operations extend as far upstream as Meridean, the designated upper boundary of the study area.

Sampling dates were not uniformly distributed either among years or among months. Sampling was concentrated in July and August during 1972 to 1974 and in May during 1975 to 1977. No sampling was done in 1978, and only two dates were sampled in 1979. Efforts during the summer months in the early years of the study were directed toward tagging and recapture of tagged fish. Sampling during the spring months in later years emphasized collection of fecundity and maturity materials and recapture of tagged fish after an extended time lapse.

Tag returns were solicited from anglers. In the spring of each year, a news release requesting return of the tags was sent to local newspapers and radio and television stations. Efforts were made to determine as closely as possible the location of capture from angler returns, but their true accuracy was unknown. Returns from anglers were received through 1983.

Results and Discussion

Tagging Activities

Between 1972 and 1977, a total of 1,222 shovelnose sturgeon were tagged. Of the 1,222 shovelnose sturgeon tagged and released in the Chippewa River during this study, 261 recaptures were made by shocking during the period 1972-1979. Among the recaptures, 210, 44, 6, and 1 were recaptured one, two, three, and four times, respectively. Most of the fish were tagged and recaptured during 1973 (Table 2) and during July and August (Table 3).

Length Frequency

Fork lengths were obtained from 1,220 sturgeon (lengths and weights of two of the tagged fish were not recorded) in the Chippewa River during the period 1972-1977. The length in intervals ranged from 19.0-19.4 to 31.5-31.9 inches, sexes combined (Table 4). The modal length interval was 24.5-24.9 inches, and 71% of the sample was less than 26.0 inches long. The length frequency of the shovelnose sturgeon population in the Red Cedar River (Christenson 1975) was essentially the same as that in the Chippewa River, but the former contained a higher proportion of larger fish (Table 4).

No sturgeon less than 19 inches were captured during this study or by Christenson (1975), although small sturgeon should have been vulnerable to the electrofishing gear employed. Two small (8.1 and 8.2 inches) lake sturgeon (*Acipenser fulvescens*) were collected in the study area, and small specimens of lake sturgeon have been collected with the same type of electrofishing gear in other waters of the state (e.g., Kempinger, 1996). Further, shovelnose sturgeon as small as 11.3 inches in fork length were taken with pulsed dc electrofishing gear in the Yellowstone River at Intake, Montana (Haddix and Estes 1976).

Table 1. *Electrofishing sampling dates for shovelnose sturgeon on the Chippewa River during 1972 to 1979.*

Year	May	June	July	August	September
1972			18,24,25	7,8,14,15	
1973	21		13,18,24,30,31	8,9,15,16	17,18
1974	29	5		1,13,20,27	
1975	15,20,28		8,9		
1976	12,17,21,25,28	2,10,21			
1977	17,25,26		26		
1978					
1979	24	13			

Table 2. *Number of shovelnose sturgeon tagged and recaptured by electrofishing in the Chippewa River by year.*

Year	Number of Fish Tagged	Number of Observations of Recaptured Fish	Total Number of Observations
1972	230	7	237
1973	771	177	948
1974	123	37	160
1975	95	36	131
1976	2	52	54
1977	1	9	10
1978	0	0	0
1979	0	2	2
Total	1,222	320	1,542

Table 3. *Number of shovelnose sturgeon tagged and recaptured by electrofishing in the Chippewa River by month.*

Month	Number of Fish Tagged	Number of Observations of Recaptured Fish	Total Number of Observations
May	67	58	125
June	0	19	19
July	341	71	412
August	581	79	660
September	233	93	326
Total	1,222	320	1,542

Despite evidence that the study area is a shovelnose sturgeon spawning site, young sturgeon simply may not have been present, perhaps spending their juvenile years in downstream nursery areas. During this study, ripe, running, and spent females and running males were collected from the study area. Kranz (1978) reported the capture of shovelnose sturgeon larvae in drift nets set in May and June in the upper part of the area encompassed by this study. In a study covering a longer reach of shovelnose sturgeon habitat in the Yellowstone River, Haddix and Estes (1976) successfully used pulsed dc electrofishing gear to capture small shovelnose sturgeon in one river reach, but failed to take small specimens in the same time period and in similar habitats in an area 166 miles upstream. It is possible that a similar longitudinal habitat differential between young and old shovelnose sturgeon also occurs in the Chippewa River.

Length-Weight Relationship

Weights were obtained from the same 1,220 sturgeon measured for lengths. The smallest sturgeon captured weighed 0.81 lb and was 19.1 inches in length. The largest was a 31.7-inch fish that weighed 7.0 lb. The average weight was 2.21 lb, with a standard deviation of $\pm$ 0.42 (Table 5).

A length-weight relationship was computed from the logarithmic transformation of the exponential function $W = aL^b$, where W was weight in pounds and L was fork length in inches. The equation $\log_{10}(W) = -4.327 + 3.333\log_{10}(L)$ best described this relationship for both sexes combined (Figure 3). The length-weight relationships for representative size intervals in the Chippewa River and Red Cedar River (Christenson 1975) were extremely close. For example, an average shovelnose sturgeon of 25.0 to 25.4 inches in length weighed 2.21 lb in the Chippewa River and 2.20 lb in the Red Cedar River.

Growth

The empirical growth of shovelnose sturgeon was determined for 169 recaptured tagged fish that had been at large for periods of 240 to 1,095 days. Fork-length intervals ranged from 21.5-21.9 to 29.5-29.9 inches. Growth increments were very small, averaging only 0.03 inch/year with no appreciable differences among fish of different sizes at tagging (Table 6). There was some individual variation in growth increments with observed growth ranging from no growth to 0.24 inch/year.

A similar pattern of very slow growth of tagged shovelnose sturgeon has been reported by other investigators. Ten tagged fish that had been at large in the Missouri River, South Dakota, for 8.9 to 11.9 years showed a mean increase in fork length of 0.34 inch with a range of 0.0 to 0.87 inch (Schuckman 1982). Schmulbach (1974) reported growth of tagged sturgeon at large in the Missouri River, South Dakota, for three years or more to be extremely slow; most had grown only 0.04 to 0.08 inch. Recaptured tagged sturgeon in Missouri showed slight or no growth over approximately a one-year period (Carlson and Pflieger 1981).

Efforts to determine age by the fin ray cross-section method were unsuccessful, probably because slow annual growth resulted in indistinguishable annuli. Others have presented data on age composition and growth based on the fin ray method (Fogle 1963, Zweiacker 1967, Helms 1974*a*, Helms 1974*b*, Durkee et al. 1979, Carlson and Pflieger 1981). Only Helms (1974*b*) was able to validate the method and then only through the first four years of life. Calculated mean fork lengths at capture, sexes combined, were 8.9, 13.7, 18.9, and 22.0 inches for ages 0, 1, 2, and 3, respectively.

Slow growth of shovelnose sturgeon has been attributed to several factors. Helms (1974*b*) ascribed reduced growth after the fourth year of life to sexual maturity. Schmulbach (1974) suggested

Table 4. *Comparison of fork-length frequencies of shovelnose sturgeon collected during May to September 1972-1977 in the Chippewa River to those collected during April to October 1967-1973 in the Red Cedar River (from Christenson 1975).*

Length Interval (inches)	Chippewa River		Red Cedar River	
	Number	Percent	Number	Percent
19.0-19.4	1	0.1		
19.5-19.9				
20.0-20.4	1	0.1		
20.5-20.9				
21.0-21.4				
21.5-21.9	4	0.3		
22.0-22.4	10	0.8	1	0.2
22.5-22.9	41	3.4	3	0.6
23.0-23.4	74	6.1	8	1.7
23.5-23.9	113	9.3	20	4.3
24.0-24.4	160	13.1	33	7.1
24.5-24.9	168	13.8	48	10.3
25.0-25.4	143	11.7	58	12.5
25.5-25.9	154	12.6	67	14.4
26.0-26.4	109	8.9	68	14.6
26.5-26.9	93	7.6	45	9.7
27.0-27.4	74	6.1	40	8.6
27.5-27.9	35	2.9	38	8.2
28.0-28.4	19	1.6	18	3.9
28.5-28.9	12	1.0	7	1.5
29.0-29.4	6	0.5	5	1.1
29.5-29.9			1	0.2
30.0-30.4	1	0.1	3	0.6
30.5-30.9				
31.0-31.4				
31.5-31.9	2	0.2	1	0.2
32.0-32.4			1	0.2
Total	1,220	100.0	465	100.0

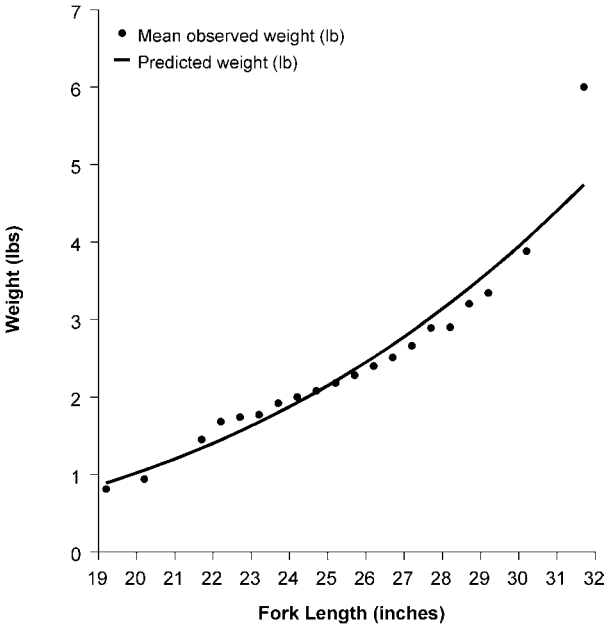

Figure 3. *Length-weight relationship of the 1,222 shovelnose sturgeon sampled.*

Table 5. *Weights of shovelnose sturgeon sampled by electrofishing in the Chippewa River, 1972-1977, by fork-length interval.*

Length Interval (inches)	Number of Fish	Average Weight (lb)	Standard Deviation (lb)	Observed Range (lb)
19.0-19.4	1	0.81		
19.5-19.9	0			
20.0-20.4	1	0.94		
20.5-20.9	0			
21.0-21.4	0			
21.5-21.9	4	1.45	0.24	1.19-1.75
22.0-22.4	10	1.68	0.17	1.44-1.94
22.5-22.9	41	1.74	0.18	1.44-2.16
23.0-23.4	74	1.77	0.17	1.47-2.53
23.5-23.9	113	1.92	0.18	1.53-2.44
24.0-24.4	160	2.00	0.19	1.50-2.47
24.5-24.9	168	2.08	0.19	1.69-2.63
25.0-25.4	143	2.18	0.23	1.25-2.75
25.5-25.9	154	2.28	0.22	1.84-3.09
26.0-26.4	109	2.40	0.22	1.75-3.06
26.5-26.9	93	2.51	0.25	1.97-3.19
27.0-27.4	74	2.66	0.27	1.84-3.31
27.5-27.9	35	2.89	0.29	2.19-3.50
28.0-28.4	19	2.90	0.25	2.44-3.44
28.5-28.9	12	3.20	0.28	2.66-3.69
29.0-29.4	6	3.34	0.53	2.66-4.16
29.5-29.9	0			
30.0-30.4	1	3.88		
30.5-30.9	0			
31.0-31.4	0			
31.5-31.9	2	6.00	1.41	5.00-7.00
All	1,220	2.21	0.42	0.81-7.00

that a large sturgeon population in the Missouri River was competing for a limited food supply and subsisting on a bare maintenance diet. Zweiacker (1967) suggested the hypothesis of determinant growth as a possible explanation for the observed slow growth pattern. Growth rate reductions due to tagging have also been implicated in other studies (Elser et al. 1977, Carlson and Pflieger 1981) and could conceivably be a factor in the slow growth exhibited by sturgeon in the Chippewa River. Varying degrees of soreness at the tag attachment site were occasionally noted on the field sheets as "slight irritation under tag," "tail little sore," "tail sore," and "tail very sore." Those terms were identified primarily with fish that had been at large up to two years. Terms such as "showed distinct compression of tag into flesh," "tags deeply imbedded in caudal peduncle," and "tag imbedded, flesh sore" were noted for fish that had been at large for three to six years.

Longevity

Although we were not able to accurately age shovelnose sturgeon in this study, a rough estimate of maximum age was made by combining lengths at age reported in the literature and observed at large periods of tagged fish in this study. Six shovelnose sturgeon were recaptured by anglers 7.8 to 8.8 years after tagging. These fish ranged from 24.4 to 28.5 inches in length at tagging. Helms (1974*a*) found shovelnose sturgeon of these size ranges averaged 7 to 12 years of age in the Mississippi River. Conceivably, then, the age of older shovelnose sturgeon in the Chippewa River could be 15 to 20 years.

Using a similar method, Schuckman (1982) ascribed 15 to 17 years of age to ten Missouri River shovelnose sturgeon released at ages 5 to 7 and recaptured 8.9 to 11.9 years later. Using direct aging of fin rays, other authors have reported maximum ages of shovelnose sturgeon in their samples to range from 10 to 27 years (Fogle 1963, Zweiacker 1967, Helms 1974*a*, Durkee et al. 1979, Carlson and Pflieger 1981).

Table 6. *Observed growth of shovelnose sturgeon in the Chippewa River based on difference between lengths at tagging and recapture by fork-length interval. Includes only recaptures at-large more than 240 days and less than 1,095 days.*

Length Interval (inches)	Number of Fish	Mean Days at Large	Standard Deviation	Mean Growth (inches/year)	Standard Deviation
21.5-21.9	1	717		0.00	
22.0-22.4	0				
22.5-22.9	2	684	418.6	0.04	0.21
23.0-23.4	6	519	280.8	-0.01	0.23
23.5-23.9	13	489	256.4	-0.08	0.16
24.0-24.4	19	521	251.4	0.07	0.24
24.5-24.9	25	573	219.2	0.01	0.13
25.0-25.4	24	629	289.9	0.04	1.81
25.5-25.9	22	541	255.3	0.01	0.28
26.0-26.4	19	615	307.2	0.04	0.10
26.5-26.9	17	601	269.7	0.05	0.13
27.0-27.4	5	553	176.2	0.00	0.12
27.5-27.9	3	576	134.0	0.04	0.02
28.0-28.4	7	593	323.4	0.11	0.14
28.5-28.9	3	712	303.5	0.23	0.43
29.0-29.4	1	399		-0.09	
29.5-29.9	2	989	30.4	0.33	0.25
All	169	579	262.4	0.03	0.19

Table 7. *Observed movement of tagged shovelnose sturgeon between 1972 and 1979 in the Chippewa River based on electrofishing recaptures.*

Direction of Movement	Time at Large								
	1d	1m	1-4m	4-12m	12-18m	18-24m	2-3y	3-6y	All
Upstream									
Number of fish	3	20	37	38	19	23	15	6	161
Mean distance	0.3	0.6	1.3	0.9	1.8	1.0	1.5	3.2	1.2
SD (±)	0.26	0.51	1.28	1.28	1.80	1.41	2.73	3.67	1.67
Range	0.1-0.6	0.1-2.1	0.1-4.1	0.1-7.3	0.1-5.7	0.1-6.2	0.1-9.8	0.2-8.7	0.1-9.8
Percent	27.2	44.2	50.0	70.3	45.2	49.0	39.5	54.5	50.3
Downstream									
Number of fish	7	19	34	14	20	19	23	5	141
Mean distance	1.6	0.8	1.5	1.0	2.04	2.02	2.3	1.5	1.7
SD (±)	1.93	1.28	1.67	1.02	2.37	2.30	1.80	1.73	1.84
Range	0.1-5.8	0.1-5.3	0.1-5.6	0.1-3.6	0.1-9.7	0.1-6.3	0.1-5.5	0.3-4.2	0.1-9.7
Percent	63.6	46.5	46.0	26.0	47.6	40.4	60.5	45.5	44.1
No movement									
Number of fish	1	4	3	2	3	5	0	0	18
Percent	9.0	9.3	4.0	3.7	7.1	10.6	0.0	0.0	5.6
Combined									
Number of fish	11	43	74	54	42	47	38	11	320
Mean distance	-0.9	-0.09	-0.04	0.4	-0.1	-0.2	-0.8	1.0	-0.1
SD (±)	1.77	1.15	2.01	1.45	2.78	2.28	2.89	3.73	2.20

Movement

A total of 320 observations were made on movement of 261 tagged shovelnose sturgeon recaptured by shocking in the Chippewa River during the 1972-1979 period. Of the 261 fish, 210 were recaptured once while 44, 6, and 1 were recaptured two, three, and four times, respectively. It was not possible to use this data set to examine patterns of seasonal or spawning movements in shovelnose sturgeon. Sampling was concentrated in a short reach of the river—too short to encompass the full range of potential spawning migrations. Also, sampling was concentrated in either spring (May-June) or late summer (July-August) in a given year so it was not possible to compare fish locations between seasons. Nevertheless, observed movement between captures does provide some general insight into movement patterns within seasons.

Shovelnose sturgeon movement within seasons was generally minimal and showed no consistent upstream or downstream pattern. Fifty percent of the 320 observations were of fish that had moved upstream an average distance of 1.2 miles (range 0.1-9.8 miles), and 44% were of fish that had moved downstream an average distance of 1.7 miles (range 0.1-9.7 miles). Six percent of the observations were of fish that had not moved, i.e., of fish that were recaptured less than 0.1 mile from the release site (Table 7). Overall average movement was 0.1 mile downstream with a standard deviation of $\pm$ 2.20 miles. Fish recaptured multiple times showed similar movement patterns. Of the 110 observations made on 51 fish, 53% were upstream, 41% downstream, and 6% showed no movement. The average movement of fish recaptured multiple times was 0.03 mile downstream with a standard deviation of $\pm$ 1.99 miles.

A rough estimate of home range was the maximum distance between locations for fish recaptured multiple times. Sample size was limited to only 51 fish, most with only three locations. However, the average observed home range was 2.1 miles and ranged from 0.1 to 7.3 miles.

These average distances were probably underestimates of within-season movement because sampling was concentrated in the central section of the study area. Tagged sturgeon in the extreme upper and lower sections of the study area were, if present, less likely to be caught due to the lesser number of sampling runs. However, other studies have also found that shovelnose sturgeon movement is minimal and nondirectional, at least within season. Moos (1978) concluded that shovelnose sturgeon in the Missouri River, South Dakota, during the year after release moved randomly back and forth within a 5 to 10 mile segment of the river. Tagged sturgeon in the upper Mississippi River recaptured within 6 to 111 days of release had travelled an average of 1.1 miles (maximum of 7.9 miles), but 28% of the tagged recaptures had moved only 50 m or less (Hurley et al. 1987). Helms (1974*a*) also reported limited movement of sturgeon in the upper Mississippi River.

Although we concluded that movement of shovelnose sturgeon observed in this study is typically minimal and showed no consistent upstream or downstream pattern, angler returns showed clearly that these fish do routinely make longer movements. Of the 1,222 tagged sturgeon released in the Chippewa River, only 18 (1.5%) were reported caught by anglers during 1972 through 1983. These limited recaptures, nevertheless, generally involved longer movements and periods at large than did electroshocker recaptures. The greatest movement was upstream for 24 miles and downstream for 21 miles. Three other fish moved upstream 19, 20, and 21 miles, and one moved downstream 19 miles to and then up the Mississippi River. Time at large bore no relationship to distance moved; e.g., two fish were each caught 3.2 miles from the release site 7.8 and 8.7 years later, while two others were each located 19 miles from the release site 0.9 and 1.7 years later.

Other studies also suggest shovelnose sturgeon are capable of moving long distances. The maximum distance moved in this study was 24 miles, but much longer distances are reported in the literature: 311-335 miles in the Missouri River (Moos 1978); 319 miles in the Missouri River (Carlson and Pflieger 1981); 135 miles in the Powder River, Montana (Rehwinkel 1978); 120 miles in the Mississippi River (Helms 1974*a*); 113-118 miles in the Mississippi River (Hurley et al. 1987); 105 miles in the Missouri River (Berg 1981); and 34 miles in the Mississippi River (Curtis 1990). It is possible that these longer movements are seasonal or spawning migrations that were outside the scope of this study.

Management Implications

Further studies on seasonal or spawning migrations of shovelnose sturgeon must be done to fully understand the threats posed by harvest and physical barriers to their movements. If spawning migrations are found to be important, it is likely that dam construction may a factor in limiting their range in Wisconsin. Currently, shovelnose sturgeon are not found above the first dam on each major Mississippi River tributary.

Management of harvest would also be affected by seasonal migrations. Wisconsin currently has relatively liberal hook-and-line limits for shovelnose sturgeon in the Mississippi River and major tributaries below the first dams (no closed season, no size limit, 25 daily bag limit). There is also a significant commercial fishery in the Mississippi River bordering Iowa (Helms 1974*a*). Depending on the extent of seasonal movements, upriver populations could be exposed to significant downriver fisheries.

Future studies are also needed to clarify the status of small shovelnose sturgeon in the Chippewa River. No fish under 19 inches was collected in this study or in the Red Cedar River by Christenson (1975). It isn't known whether smaller fish are not vulnerable to the gear used or young fish only inhabit downstream nursery areas. The use of trammel nets and electrofishing in combination could result in more accurate length-frequency distributions.

Summary

- Between 1972 and 1977 a total of 1,222 fish were captured by electrofishing, tagged, and released in the Chippewa River. Of that number, 261 sturgeon were recaptured during the period 1972-1979.
- The sturgeon population ranged in fork-length intervals from 19.0-19.4 to 31.5-31.9 inches in the Chippewa River. The modal length interval was 24.5-24.9 inches.
- Average weight of shovelnose sturgeon was 2.21 lb, and the maximum weight was 7.0 lb.
- The average growth of recaptured fish at large for 240 to 1,095 days was 0.03 inch/year. This extremely slow growth is in agreement with the findings of several other studies based on recaptured tagged fish.
- Average upstream and downstream movements within the Chippewa River were 1.2 and 1.7 miles, respectively, for the time-at-large period of one day to six years. These movement patterns are probably indicative of within-season movements only; this study was not designed to determine patterns of seasonal or spawning movements.
- Maximum distances moved as determined by electrofishing recapture were 9.8 miles upstream and 9.7 miles downstream. Recaptures by anglers were made as far upstream and downstream as 24 and 21 miles, respectively, though other studies suggest shovelnose sturgeon are capable of much longer movements.
- Anglers reported capture of only 1.5% of the 1,222 tagged sturgeon during the period 1972-1983.

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